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(54) **Pesticidal composition and method for treating seeds prior to planting**

(57) A liquid slurry seed treater formulation containing one or more pest control agents and a high solids acrylate copolymer emulsion adhesive sticker in addition to one or more suspending agents and surface active agents, water, and, optionally, other diluents, adjuvants or other additives, is applied to seeds to yield seeds having an adherent coating in which the pest control agent is dispersed.

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SPECIFICATION

Pesticidal composition and method for treating seeds prior to planting

This invention pertains to the protection of crops from plant pests, particularly from pests which attack crop seeds and seedlings.

Over the years, various methods have been employed in attempts to control crop pests that attack seeds and seedlings. Prior to the advent of seed treater formulations, there were few viable alternatives to simply sterilizing the soil, by one or more applications of a pesticide just before or just after planting. Today, the use of pesticide-treated seeds is the most frequently used method for protecting agricultural crops during the seed or seedling stage, particularly for grain or vegetable crops. Generally, the seed company or pesticide manufacturer prepares the treated seeds, which are then made commercially available to the grower. The use of pesticide-treated seeds is particularly advantageous in that it places the pest control agent at the site where pest attack will occur, and elliminates the waste attendant upon treating the entire cultivated acreage.

Treatment of seeds with a systemic pest control agent affords protection to the seed itself, to emerging roots and upward growth of seedlings vulnerable to attack by soil insects and nematodes, and to the seedlings newly emergent from the soil which are especially vulnerable to attack by above-ground insects and other pests.

Application of formulations of pest control agents to crop seeds was initially carried out in a multiple-step process by first applying a coating of adhesive sticker to the seed and then causing a formulation of pesticide dust to adhere to the sticky surface of the coating. A subsequent coating with adhesive sticker was often found necessary to prevent loss of the pesticide dust through attrition and abrasion.

More recently developed seed treater formulations incorporate the adhesive sticker, generally hydroxypropylcellulose or an emulsion of polyvinyl acetate, directly in the pesticide formulation itself, thereby allowing application of the sticker and pesticide to the seeds in a single step. While use of these formulations has greatly simplified the process of placing a pesticide coating on the seeds, treated seeds prepared from these formulations tend to be dusty. This presumably results from the coating being abraided by the seeds' coming into contact with each other during the drying step and afterwards. In addition to being unpleasant for personnel who handle the treated seeds, dustiness increases exposure to inherent hazards of the pesticide.

In accordance with the present invention substantially less dusty pesticide-treated seeds are produced when a novel liquid (aqueous) slurry seed treater formulation is used in producing the treated seeds. The present invention comprises a new seed treater formulation, a method of protecting seeds and seedlings against crop pests by applying the slurry formulation to the seeds and drying the coated seeds to remove excess liquid, and seeds having an adherent pesticide-containing coating obtained by use of the present method.

The present liquid slurry seed treater formulations contain one or more pest control agents and a high solids acrylate copolymer emulsion adhesive sticker in addition to one or more suspending agents and surface active agents, water, and, optionally, other diluents, adjuvants or other additives. The copolymer acrylate emulsion adhesive sticker should preferably have at least 50%, more preferably 60% to 70%, by weight of solids, and a viscosity in the range of 0.5 to 0.4 Pa.s at 25°C. It is particularly desirable that one of the monomers from which the acrylate copolymer is prepared be 2-ethylhexyl acrylate. Suitable multipolymer acrylate emulsions are commercially available under the Vinrez 6201 and Vinrez 6202 trademarks from Union Oil Company of California, Union Chemicals Division, Petrochemical Group, 67 Walnut Avenue, Clark, New Jersey 07066, U.S.A.

The present liquid slurry seed treater formulations contain 15% to 50% by weight active pesticide and 0.5% to 15% by weight copolymer acrylate emulsion adhesive sticker, the remainder, to 100%, being inert additives or adjuvants. The formulations are stable in storage for long periods, generally in excess of one year. Agglomeration of solids on storage is minimal. Components which do separate are easily redispersed by shaking or stirring.

The pesticide-treated seeds are prepared by applying the slurry seed treater formulation to seeds, followed by drying the treated seeds to remove excess liquid and to form an adherent coating on the seeds, the pset control agent being dispersed in the adherent coating. The pest control agent comprises 0.1% to 6% of the total weight (s ed plus coating) of the treated seeds. The coating is resistant to loss of active pesticide by attrition or abrasion, does not significantly reduce the rate of germination of the seed, and provides levels of activ pesticide which give adequate protection against crop pests.

It is contemplated that a variety of pesticides effective against soil ins cts and nematodes may be formulated by the method of the invention. Agents capable of systemic action are preferred for use in the invention. An specially preferred systemic insecticide/nematicide is 2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate ("carbofuran"). It is also contemplated that fungicidal agents may be incorporated in order to protect seeds against fungal attack which the ins cticidal and/or nematicidal agent may not effectively combat.

The present seed treater liquid slurry formulations may be produc d by admixing the copolymer acrylate emulsion adhesive sticker with

(i) technical grade commercial pesticide,

(ii) a finely divided solid pesticide base formulation useful in th formulation of granular pesticides, or

(iii) an aqueous flowable pesticide formulation, and, for (i) and (ii), and optionally for (iii), with one or more suspending agents and surface active agents, water, and other diluents, adjuvants or other additives as desired.

Suspending agents efficacious in the practice of this invention include xanthan gum (a complex polysaccharide with molecular weight above one million); purified, colloidal, sodium-modified montmorillonite; and organically refined smectite clay.

Surface active agents (surfactants) may be nonionic, cationic or anionic. Nonionic polyalkylene glycol ethers and anionic surfactants such as ester-free organic phosphate acids or the dioctyl ester of sodium sulfosuccinic acid have been found useful. It is contemplated that other nonionic, cationic, and anionic surface active agents may also be used.

Where carbofuran is the active pesticide component, it is convenient to prepare the present seed treater formulations from a carbofuran solid base formulation or a carbofuran aqueous flowable formulation.

A typical carbofuran solid base formulation containing approximately 75% by weight active ingredient will comprise, for example,

	% Wgt/Wgt
Carbofuran, technical (95% purity)	79.50
Anionic wetting agent	1.00
Clay diluents	11.00
Oil dedusting agent	0.80
Anionic clay system dispersing agent	5.00
Talc diluent	2.70
Total	100.00

Other typical carbofuran solid base formulations include those shown below which contain approximately 80%, 85%, and 90% by weight active ingredient respectively.

Carbofuran 80% Solid Base

	% Wgt/Wgt
Carbofuran, technical	84.16
Anionic wetting agent	1.06
Clay diluents	8.62
Oil dedusting agent	0.85
Anionic clay system dispersing agent	5.31
Total	100.00

Carbofuran 85% Solid Base

	% Wgt/Wgt
Carbofuran, technical	88.54
Anionic wetting agent	1.00
Clay diluents	5.06
Oil dedusting agent	0.40
Anionic clay system dispersing agent	5.00
Total	100.00

Carbofuran 90% Solid Base

	% Wgt/Wgt
Carbofuran, technical	93.75
Clay diluent	3.25
Anionic wetting and dispersing agent	3.00
Total	100.00

A carbofuran aqueous flowable formulation containing from 100 g/L to 500 g/L of carbofuran will comprise, by weight, for example:

(a) from 8 to 60% of a carbofuran solid pesticide base formulation containing from 75 to 90% by weight of carbofuran:
(b) from 0.5 to 8% of a nonionic emulsifying agent;
(c) from 0.01 to 20% of a suspending agent;
(d) from 0.005 to 0.01% of an antifoaming agent; and
(e) water;

carbofuran being present in an amount in the range of from about 100 g/L to 500 g/L of aqueous flowable formulation.

Typical carbofuran aqueous flowable formulations include those shown below:

Carbofuran 100 Flowable Formulation

	% Wgt/Wgt
Carbofuran 75% solid base	11.73
Emulsifying agent	2.00
Suspending agent	0.18
Bactericide	0.20
Antifoaming agent	0.01
Kaolin clay	18.00
Water	67.88
Total	100.00

Contains approximately 100 g/L (88 g/kg) carbofuran.

Carbofuran 200 Flowable Formulation

	% Wgt/Wgt
Carbofuran 75% solid base	23.30
Emulsifying agent	2.00
Suspending agent	0.14
Bactericide	0.20
Antifoaming agent	0.01
Kaolin clay	12.00
Water	62.35
Total	100.00

Contains approximately 200 g/L (175 g/kg) carbofuran.

Carbofuran 300 Flowable Formulation

	% Wgt/Wgt
Carbofuran 75% solid base	35.80
Emulsifying agent	2.00
Suspending agent	0.12
Bactericide	0.20
Antifoaming agent	0.01
Kaolin clay	4.00
Water	57.87
Total	100.00

Contains approximately 300 g/L (269 g/kg) carbofuran.

Carbofuran 400 Flowable Formulation

	% Wgt/Wgt
Carbofuran 75% solid base	46.80
Emulsifying agent	2.00
Suspending agent	0.08
Anionic wetting agent	0.50
Bactericide agent	0.20
Antifoaming agent	0.01
Kaolin clay	2.00
Water	48.41
Total	100.00

Contains approximately 400 g/L (351 g/kg) carbofuran.

Carbofuran 500 Flowable Formulation

	% Wgt/Wgt
Carbofuran 75% solid base	56.90
Emulsifying agent	3.00
Suspending agent	0.02
Anionic wetting agent	1.00
Bactericide	0.10
Antifoaming agent	0.01
Water	37.97
50% aqueous sulfuric acid	1.00
Total	100.00

pH 5.78

Contains approximately 500 g/L (427 g/kg) carbofuran.

Preparation of the seed treater liquid slurry formulations of this invention is described in the following examples, intended to be illustrative of the invention, but not limiting thereof. Acrylate copolymer emulsion "X" has 63% to 65% solids and a viscosity in the range of 0.8 to 3.0 Pa.s, and is commercially available under the Vinrez 6201 trademark from Union Oil Company of California, Union Chemicals Division, Petrochemical Group, 67 Walnut Avenue, Clark, New Jersey 07066, U.S.A. Acrylate copolymer emulsion "Y" has 63% to 65% solids and a viscosity in the range of 1.5 to 3.5 Pa.s, and is commercially available from Union Oil Company under the Vinrez 6202 trademark.

EXAMPLE 1

PREPARATION OF A SEED TREATER FORMULATION FROM A FLOWABLE CARBOFURAN FORMULATION (FORMULATION 1, SEE TABLE 1)

In a 120 mL wide-mouth jar were placed 10.00 g of acrylate copolymer emsulsion "X" and 90.00 g of an aqueous, flowable formulation containing 400 g/L of carbofuran. Th jar was capped, and was m chanically shaken for 10 minut s.

EXAMPLES 2—4

The seed treater formulations of these examples (Formulations 2—4) and comparative formulations A—F were prepared in the manner of Example 1 using the ingredients list d in Tables 1 and 3 in the indicated proportions.

EXAMPLE 5

PREPARATION OF A SEED TREATER FORMULATION FROM A SOLID BASE CARBOFURAN FORMULATION (FORMULATION 5, SEE TABLE 2)

Rhodamine B (4.0 g) was added to 350.2 g of tap water, and the mixture was stirred for 15 minutes at slow speed. To this mixture were added 0.1 g of dimethyl siloxane, 5.0 g of anionic phosphate acid, and 10.0 g of a copolymer of ethylene and propylene oxides. This mixture was stirred at slow speed for 20 minutes. Acrylate copolymer emulsion "X" (100.0 g) was then added and the mixture stirred at medium speed for 2—3 minutes. A 0.6% w/w solution of xanthan polysaccharide gum (116.7 g) was added and the mixture stirred at medium speed for 2—3 minutes. Carbofuran 75% solid base formulation (414.0 g) was added and the mixture stirred at high speed for 15 minutes. The resulting liquid slurry formulation was passed through a 100 mesh (0.149 μm) screen to insure that no agglomerates were present. The pH of this formulation was 8.0, its viscosity as measured by a Zahn cup #3 was 20 seconds, and it contained 360.7 g of carbofuran.

EXAMPLES 6—12

The seed treater formulations of these examples and comparative formulations G and H were prepared in the manner of Example 5 using the ingredients shown in Tables 2 and 4.

Samples of selected formulations were placed in 250 mL wide-mouth jars for storage stability tests. One sample of each formulation was stored at room temperature and a second sample was stored at 50°C. Observations of the amount of phase separation, the settling out of solids, and the tendency of the formulation to gel were made periodically, usually after 1, 3, 5, and 8 months of storage. Tables 5 and 6 show the storage stability of formulations.

EXAMPLE 13

TREATMENT OF WHEAT SEED WITH FORMULATION 5 (SEED TREATMENT, LOT k)

Formulation 5 (Example 5) (6.75 g) was added to 293.25 g of Yorkstar wheat seed in a wide-mouth jar. The two components were mixed with a spatula until all the seed was wet. The jar was closed and placed on a mechanical roller for 4 minutes. The treated seed was then placed in an evaporating dish and allowed to air dry for 72 hours. The calculated amount of carbofuran on the seed was 0.7%. It was found that 0.0009 g of dust could be collected from 20 g of treated seed. The amount of dust was determined by placing 20 g of treated seed in a Kjeldahl connecting bulb which was attached to a rotary evaporator. A special glass apparatus made from a 5.5 cm diameter screw-top glass jar with the bottom replaced by a standard glass taper seal joint was placed at the outlet of the Kjeldahl connecting bulb. The cap of the jar was thoroughly perforated with 1.6-mm holes. A tared 5.5 cm Whatman #1 filter paper was placed in the cap, and the cap was used to close the open end of this special glass apparatus. The inlet of the Kjeldahl connecting bulb was connected to an air supply flowing at 9000 mL/min. that was controlled by a rotameter. The rotary evaporator was turned on for 10 min. with the air stream passing over the tumbling seed and then through the filter paper. The weight gain of the filter paper during this operation represented the dust from the 20 g sample of seed.

The properties of wheat treated with formulations 1 through 5 and comparative formulations A through H are summarized in Table 7.

EXAMPLE 14

TREATMENT OF BARLEY SEED WITH FORMULATION 5 (SEED TREATMENT LOT n)

Formulation 5 (Example 5) (6.75 g) was added to 293.25 g of Schuyler barley seed in a wide-mouth jar. The two components were mixed with a spatula until the seed was wet. The jar was closed and placed on a mechanical roller for 4 minutes. The treated seed was then placed in an evaporating dish and allowed to air dry for 72 hours. The calculated amount of carbofuran on the seed was 0.7%. It was found that 0.0002 g of dust could be collected from 20 g of seed. The properties of barley seed treated with formulation 5 and comparative formulations G and H are summarized in Table 8.

EXAMPLE 15

TREATMENT OF CORN SEED WITH FORMULATION 5 (SEED TREATMENT LOT q)

Formulation 5 (Example 5) (14.19 g) was added to 285.81 g of field corn seed contained in wide-mouth jar. The two components were mixed with a spatula until the seed was wet. The jar was closed and placed on a mechanical roller for 4 minutes. The treated seed was placed in an evaporation dish and allowed to air dry for 72 hours. The calculated amount of carbofuran on the seed was 1.5%. It was found that 0.0003 g of dust could be collected from 20 g of seed. The properties f corn seed treated with formulations 5 and comparative formulations G and H are summarized in Table 9.

TABLE 1
Seed Treater Formulations Prepared from Carbofuran Aqueous Flowable Formulations

Formulation, %	1	2	3	4
Carbofuran, 400 g/L flowable formulation	90.00	90.00	95.00	95.00
Acrylate copolymer emulsion "X"[a]	10.00		5.00	
Acrylate copolymer emulsion "Y"[a]		10.00		5.00

[a] Viscosity — Brookfield RVF, 20 RPM at 25°C
"X" = 0.8—3.0 Pa.s
"Y" = 1.5—3.5 Pa.s

TABLE 2
Seed Treater Formulations Prepared from Carbofuran Solid Base Formulations

Formulation, %	5	6	7	8
Carbofuran 75% base	41.40	42.70	42.70	52.10
Acrylate copolymer emulsion "X"[a]	10.00	8.00	8.00	7.00
Acrylate copolymer emulsion "Y"[a]				
Anionic phosphate acid	0.50			
Polyalkylene glycol ether		2.00	2.00	3.00
Copolymer of ethylene and propylene oxides	1.00			
Dialkylphenoxypoly-(ethyleneoxy)ethanol				
Xanthan polysaccharide gum	11.67[c]	0.12	0.09	
Potassium sorbate		0.10	0.10	
Dimethyl siloxane	0.01	0.01	0.01	0.01
50% sulfuric acid				0.75
Rhodamine B[d]	0.40	0.40	0.40	0.40
Water	35.02	46.67	46.70	36.74
Active ingredient				
g/L intended	350	400	400	450
g/L assayed	360.7	397.5	397.8	451.8
Viscosity[b] (secs)	20.0	30.0	23.0	35.0
Agglomerates (on 100 mesh)	Trace	None	None	None
pH	8.00	8.23	8.23	6.10
Carbofuran 75% base	52.10	52.10	52.10	52.10
Acrylate copolymer emulsion "X"[a]	7.00			7.00
Acrylate copolymer emulsion "Y"[a]		7.00	7.00	
Anionic phosphate acid				1.00
Polyalkylene glycol ether	3.00	3.00	3.00	2.00
Copolymer of ethylene and propylene oxides				
Dialkylph noxypoly-(ethyleneoxy)ethanol				1.00

TABLE 2 (Continued)
Seed Treater Formulations Prepared from Carbofuran Solid Base Formulations

Formulation, %	9	10	11	12
Xanthan polysaccharide gum				
Potassium sorbate				
Dimethyl siloxane	0.01	0.01	0.01	0.01
50% sulfuric acid		0.75		
Rhodamine B	0.40	0.40	0.40	0.40
Water	37.49	36.74	37.49	36.49
Active ingredient				
g/L intended	450	450	450	450
g/L assayed	450.9	452.1	451.7	446.3
Viscosity[b] (secs)	25.0	32.0	24.0	29.5
Agglomerates (on 100 mesh)	None	None	None	None
pH	8.57	6.02	8.55	7.50

[a] Viscosity — Brookfield RVF, 20 RPM at 25°C
"X" = 0.8—3.0 Pa.s
"Y" = 1.5—3.5 Pa.s
[b] Measured by a #3 Zahn cup
[c] Added as 0.6% w/w aqueous solution

TABLE 3
Composition of Seed Treater Formulations Prepared for Comparative Purposes
(Prepared from Carbofuran Aqueous Flowable Formulations)

Formulation, %	A	B	C	D	E	F
Carbofuran, 400 g/L flowable formulation	90.00	90.00	90.00	95.00	95.00	95.00
Polyvinyl acetate emulsion	10.00			5.00		
Ethyl acrylate polymer emulsion		10.00			5.00	
Vinyl acetate/acrylate multipolymer emulsion			10.00			5.00

TABLE 4
Composition of Seed Treater Formulations Prepared for Comparative Purposes (Prepared from Carbofuran Solid Base Formulations)

Formulation, %	G	H
Carbofuran 75% base	41.40	41.40
Polyvinyl acetate emulsion	12.00	
Polyvinyl alcohol emulsion		12.00
Anionic phosphate acid	0.50	0.50
Copolymer of ethylene and propylene oxides	1.00	1.00
Xanthan polysaccharide gum	11.67[b]	11.67[b]
Dimethyl siloxane	0.01	0.01
Rhodamine B	0.40	0.40
Water	33.02	33.02
Active Ingredient		
g/L intended	350	350
g/L assayed	351.7	350.6
Viscosity[a] (secs)	32.0	45.0
Agglomerates (on 100 mesh)	Trace	Trace
pH	8.11	8.15

[a] Measured by a #3 Zahn cup
[b] Added as 0.6% w/w aqueous solution

TABLE 5
Stability of Carbofuran Seed Treater Formulations
Stored at Ambient Temperatures

Formulation	5	6	7
After 1 month			
Separation	2%	Trace	Trace
Settling out	None	None	None
Gel tendency	None	None	None
After 2 months			
Separation	8%	6%[a]	10%[a]
Settling out	None	None[a]	Trace[a]
Gel tendency	None	None[a]	Slight[a]
After 5 months			
Separation	17%		
Settling out	None		
Gel tendency	v. Slight		

[a] 3 months storage

TABLE 6
Stability of Carbofuran Seed Treater Formulations Stored at 50°C

Formulation	5	6	7
After 1 month			
Separation	17%	16%	19%
Settling out	None	None	None
Gel tendency	None	None	None
After 2 months			
Separation	18%	32%[a]	31%[a]
Settling out	None	None[a]	None[a]
Gel tendency	None	None[a]	None[a]
After 5 months			
Separation	25%	17%	25%
Settling out	None	None	None
Gel tendency	v. Slight	v. Slight	v. Slight
After 8 months			
Separation		12%	14%
Settling out		None	None
Gel tendency		Moderate	Heavy

[a] 3 months storage

TABLE 7
Wheat Treated with Carb furan Seed Treater Formulation

Seed Treatment Lot No.	a	b	c	d	e
Yorkstar Wheat Seed, %	97.80	97.80	97.80	97.80	97.80
Formulation 1, %	2.20				
2, %		2.20			
A, %			2.20		
B, %				2.20	
C, %					2.20
Dust, g/20 g seed	0.0002	0.0005	0.0118	0.0052	0.0074

Seed Treatment Lot No.	f	g	h	i	j
Yorkstar Wheat Seed, %	97.80	97.80	97.80	97.80	97.80
Formulation 3, %	2.20				
4, %		2.20			
D, %			2.20		
E, %				2.20	
F, %					2.20
Dust, g/20 g seed	0.0030	0.0038	0.0137	0.0099	0.0123

Seed Treatment Lot No.	k	l	m
Yorkstar Wheat Seed, %	97.75	97.75	97.75
Formulation 5, %	2.25		
G, %		2.25	
H, %			2.25
Dust, g/20 g seed	0.0009	0.0104	0.0137

TABLE 8
Barl y Treated with Carbofuran Seed Treater Formulation

Seed Treatment Lot No.	n	o	p
Schuyler Barley Seed, %	97.75	97.75	97.75
Formulation 5, %	2.25		
G, %		2.25	
H, %			2.25
Dust, g/20 g Seed	0.0002	0.0009	0.0098

TABLE 9
Corn Treated with Carbofuran Seed Treater Formulation

Seed Treatment Lot No.	q	r	s
Field Corn Seed, %	97.27	97.27	95.27
Formulation 5, %	4.73		
G, %		4.73	
H, %			4.73
Dust, g/20 g Seed	0.0003	0.0023	0.0022

CLAIMS

1. A seed treater composition for use in application as an aqueous slurry to plant seeds to protect seeds and seedlings against plant pests, characterized in that it contains one or more pest control agents and 2-ethylhexyl acrylate copolymer emulsion adhesive sticker in admixture with one or more suspending agents and surface active agents, water, and, optionally, other diluents, adjuvants, or other additives, the 2-ethylhexyl acrylate copolymer emulsion adhesive sticker having a viscosity of 0.5 to 4.0 Pa.s at 25°C.

2. The seed treater composition of claim 1 characterized in that the pest control agent comprises 15% to 50% by weight, and the 2-ethylhexyl acrylate copolymer emulsion adhesive sticker comprises 0.5% to 15% by weight, of the seed treater composition.

3. The seed treater composition of claim 2 characterized in that the 2-ethylhexyl acrylate copolymer emulsion adhesive sticker has a solids content of 60% to 70%, and a viscosity of 0.8 to 3 Pa.s at 25°C.

4. The seed treater composition of claim 2 characterized in that the 2-ethylhexyl acrylate emulsion adhesive sticker has a solids content of 60% to 70%, and a viscosity of 1.5 to 3.5 Pa.s at 25°C.

5. The seed treater composition of claim 2 characterized in that the pest control agent is 2,3-dihydro-2,2-dimethylbenzofuran-7-yl methylcarbamate.

6. A method of protecting plant seeds and seedlings against crop pests characterized by applying to the seeds the seed treater composition of claim 1, 2, 3, 4, r 5, and drying the treated seeds to remove excess liquid.

7. Plant seed protect d against crop pests by an adherent coating containing one or more pest control agents characteriz d in that the coating is obtained by applying to seeds to be protected the seed treater composition of claim 1, 2, 3, 4, or 5, and drying the treated seeds to remov excess liquid.

8. The plant seed of claim 7 characterized in that the pest control agent in the adherent coating is 2,3-dihydro-2,2-dimethylbenzofuranyl-7-yl methylcarbamate, which pest control agent comprises 0.1% to 6% of the weight of the protected seed.

9. The plant seed of claim 8 characterized in that the seed is wheat, barley, or corn seed.

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